Land-Water Linkages in Rural Watersheds Case Study Series

The watershed council as a mechanism for upstream-downstream cooperation: The case of the Río Machángara, Cuenca, Ecuador

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Introduction and description of the watershed

The valley of the Machángara River is situated between the western and eastern mountain range of the Andes in the southern part of Ecuador, 400 km south of Quito, draining into the Amazon watershed.

The Andes form valleys going north-south through Ecuador. The oldest geological formations are found in the south-central part of the country, which for a long time have had human settlements based on the exploitation of resources. The rivers that go through Cuenca, a city with about half a million inhabitants in its immediate surroundings have always formed a nervous system on which development has been based, not only from the survival point of view, as these have provided water as a resource of life, but on the cultural and human point of view giving an identity to the people who were born and have grown on their shores.

The total area of the Machángara watershed is 325.7 km². Its waters are used for the Industrial Park of the town of Cuenca, comprising about 120 industries that represent 50 percent of the industries located in the town, and for the supply of drinking water with the Tixan[1] treatment plant and other smaller ones, the generation of hydroelectricity (38.4 MW), the irrigation with the Machángara and "La Dolorosa", system, livestock and fish farming. Currently there is a great demand of the resource, which is superior to the available supply; this generates problems amongst users, as the shortage in specific periods of the year is critical, obliging serious rationing of the resource.

The creation of the watershed council can be considered as a pioneer activity in Ecuador. The present case study wants to contribute to the knowledge and the diffusion and analysis of this management system for consideration in future conservation tasks and administration of resources, especially water.

Climate

Equatorial meso-thermal climate semi-humid to humid[2] is the most characteristic climate of the inter-Andean region, except for warm valleys and regions that are located over 3 200 m.a.s.l. The average temperature year round are usually between 12 ºC and 20 ºC, but in occasions can be inferior on slopes less exposed to the sun. The lowest temperatures seldom reach below zero and the highest do exceed 30 ºC. The temperature varies in function of the altitude and the relative humidity which

[1] With a flow of 860 L/s, the plant supplies about 45 percent of the town of Cuenca

[2] Pierre Pourrut /ORSTOM l´Institut Francais de Recherche Scientifique pour le Développement en Cooperation "The water in Ecuador, Climate, precipitations"

varies between 65 and 85 percent. The duration of the sunshine varies between 1 000 to 2 000 hours per year. Yearly rainfall fluctuates between 500 and 2 000 mm and divided in two rainy seasons from February to May and in October-November. The main dry season goes from June to September, it is very marked, but not the second one, its duration and localization in time are random, mainly inferior to 3 weeks and located at the end of December.

An analysis of rainfall (1964 to 1995) in stations of the high and middle watershed of the Paute River shows that the months of June, July and August each year have the lowest rainfall, while in the low part of the watershed, the registered rainfalls are the highest in these months.

Location

The Machángara Watershed is located in the Provinces of Azuay (blue outline) and Cañar, between the geographical coordinates 79º 8' 00" to 79º 21' 00" longitude W 02º 5' 00" latitude S to 02° 24' 00" latitude.

[**Click to view Figure 1: Location of the Machángara watershed in Ecuador**]

Land and water use in the Machángara watershed

Land use[3]

To determine the dynamic of land use change in the watershed of the Machángara River during the last 40 years, photo interpretation was used on aerial photography from 1962, 1989 and 1995.[4] The dates were chosen according to the available information.

The following table illustrates land use in the Machángara watershed in 1962.

[3] Source: Nancy Sarmiento, Environmental Management of ETAPA/2001

[4] Due to the measuring scales and the quality of the aerial photography, when analyzing the results obtained, a margin of error of +/- 5 percent must be considered.

Table 1: Soil cover in 1962

Soil cover	Area (ha)	percent
Highlands	21 346	65,6
Dwarf oak	4 132	12,7
Crops (70 percent) Pasture (30 percent)[5]	3 546	10,9
Pasture [4]	2 325	7,2
Quinoa Forest	791	2,4
Lagoon	152	0,5
Eucalyptus Forest	114	0,4
Demoted soil	110	0,3
Populated area	1	<0,1
TOTAL		**100**

[**Click to view Figure 2: Soil cover in the Machángara watershed, 1962**]

Table 2 shows types of land use and existing vegetation in the Machángara River watershed in 1995.

Table 2 Soil cover in 1995

Soil cover	Area (ha)	percent
Highlands	20 736	63,8
Shrub	4 483	13,8
Cultivation (70 percent) Pasture (30 percent)	3 462	10,7
Pastures	1 703	5,2
Eucalyptus Forest	861	2,7
Quinoa Forest	808	2,5
Lakes	211	0,7
Populated area	135	0,4
Degraded land	92	0,3
TOTAL		**100**

[**Click to view Figure 3: Soil cover in the Machángara watershed, 1995**]

The following table shows the different types of vegetation cover in 1962, 1989 and 1995.

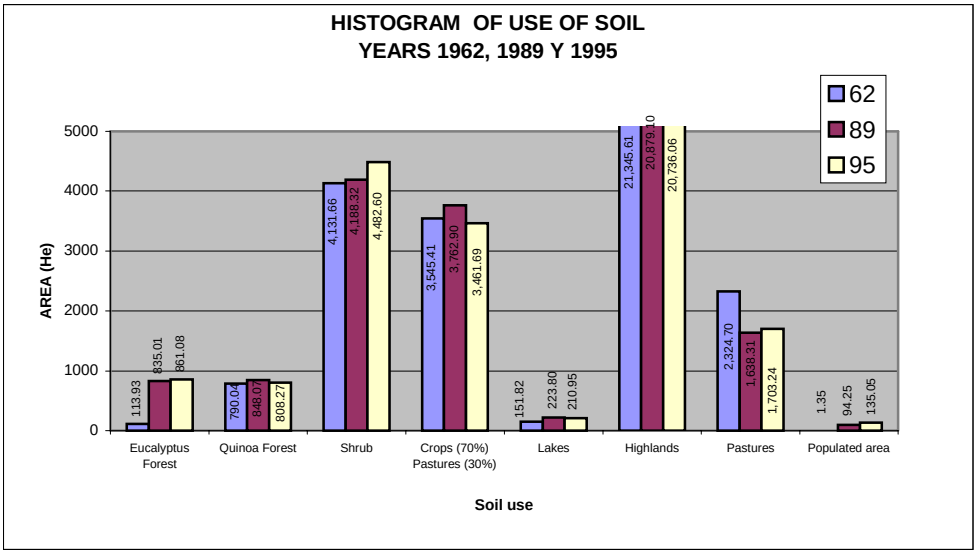
[5] Two different categories in reference with “pastures” and “pastures and crops” were differentiated. At altitudes lower that 3 000 m.a.s.l. pasture land normally includes seasonal crops, whereas in higher regions, due to altitude and climate, no crops are grown.

Table 3: Change of soil cover between 1962 and 1995 (ha)

Soil cover	1962	1989	1995
Eucalyptus Forest	114	835	861
Quinoa Forest	790	848	808
Shrub	4 132	4 188	4 483
Crops (70 percent) Pastures (30 percent)	3 545	3 763	3 462
Lakes	151	224	211
Highlands	21 346	20 879	20 736
Pastures	2 325	1 638	1 703
Populated area	1	94	135

The following figure shows net areas of vegetation cover in the year 1962, 1989 and 1995.

Figure 4: Vegetation cover between the years 1962, 1989 and 1995



Analysis of land use change

Rural settlements: In 1962, what is today known as the Parishes of Checa, Chiquintad, Sinincay, the houses were very scattered, the only populated centre was the around the Ecuadorian Rubber Company found in the lower region of the watershed. Between 1962 and 1989, the parishes of Checa, Chiquintad and Sinincay are consolidated, the neighborhoods of the "Orquideas" and Kennedy appear; the Industrial Park is conformed in a large nucleus as well as the Municipality's slaughterhouse. The population growth ratio in these six years almost double in relation to 1962-1989, this shows that the pressure on land in areas that can be developed. The lower areas of the watershed have seen a strong growth in the last years and settlements have basically replaced farming lands.

Reforestation with eucalyptus: In 1962, most of the eucalyptus forest was found on the lower parts of the Machángara and Patamarca Rivers, on the terraces east from the River Machángara and in the slopes of the terrace east from the Machángara River. Until 1989, there is an increase in eucalyptus forest, a growth ratio of reforestation of 28 ha/year. The forest is located around the rivers, in the slopes of the terraces and in the regions that were degraded in 1962.

Table 4: Change in soil cover 1962-1995

Vegetation	Increase (ha)	Decrease (ha)	Rate Increase (ha/year)	Ratio Decrease (ha/year)
Highland Páramo				
1962-1989	418	880	15.48	32.59
1989-1995	512	650	85.33	108.33
Shrub / Chaparro				
1962-1989	1008	949	37.33	35.15
1989-1995	896	602	149.33	100.33
Crops				
1962-1989	901	679	33.37	25.15
1989-1995	319	613	53.17	102.17
Pastures				
1962-1989	632	1318	23.41	48.81
1989-1995	468	403	78.00	67.17
Quinua forest				
1962-1989	250	192	9.26	7.11
1989-1995	218	258	36.33	43.00
Eucalyptus forest				
1962-1989	759	38	28.11	1.41
1989-1995	353	327	58.83	54.50
Lakes				
1962-1989	94	22	3.48	0.81
1989-1995	22	35	3.67	5.83
Degraded land				
1962-1989	30	108	1.11	4
1989-1995	74	14	12.33	2.33
Populated area				
1962-1989	93	0	3.44	0
1989-1995	47	6	7.83	1.00

Advance of the farming frontier: Until the 1960's, feudalistic structures dominated in Ecuador, until in 1964, the Agrarian Reform Law, divided the large properties of the landowners to the families living on their grounds and working for them, with the aim to give incentives to agricultural production. In the pictures of 1989 the impacts of the Agrarian Reform are shown, the pasture areas of pasture that existed in 1962, have been replaced by crops, highlighting the division of land. As a result of this division and replacement of pasture with crops, in the middle area the shrubs started

to be cleared for new pastures. In the period of 1962 and 1989 the crops were mainly replaced by eucalyptus forests and populated centers.

In the period of 1989 and 1995, the crops were abandoned and replaced in order of importance by eucalyptus forests, regeneration of shrubs, pastures and populated centers. This abandonment of agricultural land could be caused by the large migration that the parishes of Checa and Chiquintad have experienced these last years.

Pasture: In the period of 1962-1989 the pastures diminished and were replaced mainly by crops, as it was explained previously due to the effects of the Agrarian Reform. In the period of 1989 and 1995, the pastures have a very active dynamic, in some places some areas of pasture are abandoned and there is the regeneration of the shrub, while in other places the shrub cleared and replaced by pasture. Between these years the rated of increase is bigger than the decrease, which reflects the growth of the diary farm frontier.

Regeneration and deforestation of shrub[6]: the dominating process in the regeneration, the largest net growth is presented between the years 1989 and 1995, but also there is the evidence of the deforestation of many hectares of shrub product of the advance of the diary farms. Between the years 1962 and 1989 many hectares of shrub were transformed in pastures, highlands and crops as a result of slash and burn practices.

Between the years 1989 and 1995, the reforestation ratio was triplicated in relation with the previous years, this being the product of clearing and burning the shrub. As a result of the deforestation 333 ha were replaced by pasture, 215 ha by highland and 32 ha by crops.

About the regeneration ratio between 1989-1995 it is higher than the deforestation of this period. The regeneration is produced generally in the high areas and with steep slopes of the shrub fringe, and in the southern part of the middle and high areas of the watershed it is due to the abandon of crops and pastures.

Deforestation and regeneration of quinua: the quinua forest shows a very dynamic process, mainly in the highlands: on one side there is burning and in the other there is regeneration. Between the period of 1962-1989, 170 ha of quinua were converted in highland, and 218 ha of quinua were regenerated in the same period. Between 1989-1995 227 ha were burnt and 207 ha were regenerated.

Highlands: The diminution of the highland is due mainly to the regeneration of the shrub, of the quinua forest and the appearance of dams.

[6] Term used in some Andean countries to describe the floral composition; mainly bushes, of little height, characteristic o the regions of more that 2000 m.a.s.l.

Conclusions

The vegetation coverage and land use, in the Machángara River watershed, during the last forty years has undergonbe considerable change. There is evidence that while in some parts there is burning and felling of forests in other parts it is regenerated.

With regard to shrub vegetation in the last forty years, conversion into pasture has been dominant. Even though the rate of increase ratio is only 49 ha/year, it is important to say that the increase ratio is of 149.33 ha/year and the decrease ratio of 100.33 ha/year.

Reforestation with eucalyptus has helped significantly to stabilize the areas of degradation and lower the suspended sediments in the river, even if it does not have a big impact on the total watershed area, its distribution and its location (close to the water course) have produced this effect.

There is a strong pressure on the land that can be developed in the low part of the watershed because the populated centers have grown significantly.

It can be observed that the growth rate of the pastures is always superior to the rate of decrease, as dairy farms continue to convert shrub to pasture.

Water use

In the seventies the consolidation of the so called Industrial Park of Cuenca began, and an important subdivision of the farmland occurred. Thus, in the seventies and the eighties water demand grew most in the industrial and farming sector. This increase of demand coincided with the expansion of the exploitation of water resources for energy generation.

In the nineties the construction of the Chanlud[7] reservoir and the drinking water treatment plant at Tixán[8] were concluded. This caused a considerable increase in demand that lead to conflicts among demands from users as well as the natural environment which are still present today.

[7] For hydroelectric production; capacity: 25 Hm^3

[8] Capacity: 0.8 m^3/s. With the construction of the final phase (2005) the capacity will be increased to 1.6 m^3/s.

Problems related to the use of waters and soils

Overexploitation of water and water concessions

In 1999 an agreement was reached with the National Counsel of Water Resources (CNRH) to do a study comparing the actual availability of the resource with existing water concessions. Technicians of the CNRH did the study, of ETAPA and the University of Cuenca, they covered the watercourse looking for outlets and connections to measure their capacity and how much of their capacity was used. On the other side an inventory was made of all the existing water concessions in the watershed, to be able to characterize the demand. It was shown that the concessions were approximately double of the water availability. That this kind of work was the first one done in Ecuador and given its important result, it is going to be done in other watersheds.

The competitive use of the water resources are reinforced by the water concessions granted by the state. When a concession for a determined quantity of water in one point of the watershed is granted, the users can take it without caring if the remaining water is enough for other concessioned users or instream requirements.

Erosion

The problem of erosion has been increasing. proof of this is the growing accumulation of sediments in the Paute dam, a hydroelectric power station located downstream from the Río Machángara. This problem not only brings serious consequences to the hydroelectric sector as it becomes necessary to dredge the reservoir, but also to the domestic and industrial water supply sectors. When the water quality degrades, the treatment becomes more complicated, more expensive or, as it can be seen in the following example, even impossible.

Contamination

The processes of degradation of the water due to contamination have been accentuated in these last three decades, the location of the industrial park in the lower part, the presence of the municipality's slaughterhouse without any treatment whatsoever, the appearance of agro-industries (flower farms for exportation) plus the almost total lack of treatment of domestic sewage in the rural areas (the wastewater of the urban area is treated in a water treatment plant since 1999).

Landslide in the Machángara Watershed: Example of a violent erosive process

Besides having done a lot of harm to the environment, especially to the river and its ecosystem, erosion has generated as series of related problems, as the lack of resources for drinking water, the plugging of pipes and canals. The situation is such that it has put at stake the role that the Machángara watershed council in the community, as the pressure of the great public demands immediate solutions and requiring answers to a problem of this magnitude, which cannot be given easily.

In the analysis of the aerial photography of the year 1989, it is mentioned that in the high watershed of the Machángara River, there is a landslide in the Soroche stream. External actions by the communities in the area provoked the drainage of a swamp which resulted in an alteration of the runoff regulation process. Higher peaks became an important contribution to the flow, which has caused the reactivation of the landslide starting from the destabilization of the bank.

The Soroche watershed has a surface of 616.3 ha, the region presents the morphology of a glacier valley and it is formed by massive volcanic rocks (andesitic lava, tobas), covered with a layer of black soil with a thickness between 0.5 m and 1 m. The main soil cover is shrubs with native trees and bushes and herbaceous vegetation which gives the region a high relative humidity.

The landslide has a main semicircular shape about 20 to 30 m high, the width of the moved mass is approximately of about 60 m and its longitude between 80 to 100 m. The landslide mobilized at least 400 000 m^3 of rock and soil; most of it formed a mud and rock flux that moved by the streambed and flows into the Machángara River.

[**Click to view Figure 4: Landslide on Río Soroche**]

Conclusions:

The landslide was produced as a result of the reactivation of the unstable area, and most of the mass has already been transported as mud and rock flux, thus the actual exposed rock is mostly massive and hard.

The intensity and quality of the occurred landslide has caused the suspended sediment concentration to be excessively high and unacceptable for the town of Cuenca's drinking water treatment plant. Itmakes the irrigation system difficult and produces a serious degraded land in the quality of the water downstream.

Source: Report elaborated by the Technical Secretariat of the Watershed Council, August 2001

Institutions involved in land and water management

National Council of Water Resources (CNRH) Government organization at national level which governs the management and administration of water according to the Law of Waters and its regulations.

Provincial Council of Azuay **S**tate organization that plans and executes basic works such as roads, schools, environmental issues and inter-institutional coordination with government institutions of the province's local government.

Center of Economical Restructuring of Azuay, Cañar and Morona Santiago (CREA) Regional entity oriented to plan the development; it is mixed, state and private.

Electric Company of the South (ELECAUSTRO) Semi-statal body in charge of generating electricity, through hydroelectric plants located in the Machángara watershed thermoelectric plants located at El Descanso and Monay.

Municipal Company of Telecommunications, Drinking Water and Sewage (ETAPA) Company that is in charge of telecommunications, drinking water, sewage, environment inside the Cuenca County.

General Committee of Users of the Irrigation System Machángara (JGUSRM) Users organization that comprises 4 500 families in the area of the Machángara irrigation canal.

University of Cuenca. The oldest University in the south, its objective is to help the country's development from the formation of professionals to the extension and research.

The council for the Machángara watershed

History

Many things had to happen before getting to the formation of a watershed council, a lot of time and some special circumstances described below.

In 1996, the Tixán drinking water treatment plant went into operation. Operated by ETAPA, the plant is located in the middle watershed of the Machángara and works with 860 L/s in its first phase. From 2010, it is planned to double this capacity.

Competition among water uses is more acute in the lower and middle part of the watershed, particularly between drinking water and water used for irrigation.

There is evidence that the superior and middle part of the riverbed of the Machángara River is completely dry during droughts, due to the total use of its water for hydroelectric generation. The water is taken from the foot of the reservoir in pressure pipes to the generation plant which run parallel to the riverbed, leaving the section of the river between reservoir and power station dry.

Different actors and ETAPA asked that this situation be reversed to leave a minimum flow, called "ecological flow" in the stream at all times. To this end, an agreement was signed by ETAPA / EERCS / CREA /CNRH / U.CUENCA on March 6th, 1998, to maintain the ecological flow. It was signed. As this agreement was not enough to resolve all the problems that needed to be addressed, it was decided to create a Watershed Council for the Rio Machángara. This body would work on the basis of plans and strategies that would allow a sustained management of the water resources,

involving as many actors in the watershed, and trying to resolve in an integral way the problems according to a conservation vision.

To this, the Strategy for the Management of Water Resources in Ecuador is added, which recommends the need to establish in the country a new integral management system of these resources, that would allow the State to regulate and control the good use and an optimum management of the water, through a participatory process with the involvement of the different actors. On this basis, principles and strategies that are directed towards the conservation and a correct management of the resource are applied.

Thus, an Inter-institutional Cooperation Agreement was worked out creating the Watershed Council for the integral management of the hydrographic watershed of the Santiago River with its application in the micro-watershed of the Machángara River. The agreement was signed by the Center of Economical Restructuring of Azuay, Cañar and Morona Santiago – CREA, the National Counsel of Water Resources – CNRH, The Provincial Counsel of Azuay, Electric Generator of the South – ELECAUSTRO, the Public Municipal Company of Telecommunication, Drinking Water and sewage – ETAPA, and the General Committee of Users of the Machángara Irrigation System – JGUSRM.

Objectives and vision

The **main objective** of the agreement is to achieve an effective coordination between the participating institutions and the users of the watershed, the sustainable development of the watershed or hydrographic system, with emphasis in the management of the water resources, as part of the management of natural resources.

Specific objectives are

1. to develop an integral management of the water resource in the jurisdiction of the watershed under the Agreement, taking as a base the regulations of the CNRH, as well as the principles of the Declaration of Morelia in 1998, the constitutive meeting of the RIOC.

2. Create a "Technical Management Committee" which will be an autonomous and democratic body that involves the actors and public and private users. This committee will have as fundamental function the integral management the Water Resources of the watershed and to fulfill the "Integral Management Plan of the Watershed" as a basis for the environment management and the sustainable development of the region.

3. Take advantage of the resources that the institutions have in their field of competence and facilitate their technical cooperation. Contribute to the exchange of information and scientific experience as well as technology in the required areas of the project.

4. Incorporate every year in the institutional budget an entry as counterpart to specific programs and projects related with the activities that will develop the "Technical Committee of the Management".

Vision of the Council of the Machángara River Watershed: The Council of the Machángara River Watershed in the year 2010 constitutes a network which is a national leader in the integral management of the hydrographic watersheds with a clear environmental sensibility:

- has generated a culture for water in the population of the region;
- supports the water, environment and energy services;
- promotes the farming and industrial production;
- promotes the territorial legislation;
- bases its actions in the know-how and experiences of highly capacitated human talents, compromised and disposed to multiply their realizations in the region and the country;
- has conceived a political framework; laws and norms accepted by society;
- impulses proposals in environment, information exchange, prevention of disasters, with national and international institutions of watersheds for the sustainable management of the natural resources.

Structure and operation of the Watershed Council

The **Watershed Council Plenary** comprises the maximum authorities of each institution or represented body, plus a representative of the user committee, and the President of the Technical Committee who acts as secretary. The plenary meets once a year to approve the Operative Plan for the following year, as well as the budget.

The Council is supported by a **Technical Committee** , which is formed by technical representatives of each cooperating institution. The committee meets once a month, acting as permanent secretary of this committee is the Director of the Technical Secretary, , and amongst its functions have to prepare an Operative Plan.

The secretary of this Committee is the director of the **Technical Secretariat** which operates permanently. This office is in charge of preparing an operative plan and work programs. It collaborates with the users' committee that forms a part of the Watershed Council.

The **Assembly of Users** functions independently, as much in the constitution as in the operation, it maintains a representative in the plenary and in the technical committee. The assembly comprises all water users in the Machángara watershed who will elect

one representative to the Council plenary. As of yet, the assembly has not yet constituted itself, but a first meeting is foreseen in the near future.

Activities of the Watershed Council

The activities of the Watershed Council have been very diverse and include:

- Participation in the characterization, monitoring, design and implementation of solutions for the landslide of the Río Soroche.
- Analysis of the water and soil quality in the watershed.
- Purchase and installation of four hydro-meteorological stations for data acquisition in the watershed. These stations are connected to the unified monitoring network of the Paute watershed.
- Characterization of the rights to use the water versus the real availability of the resource[9], constituting the first study of this sort in Ecuador.
- Elaboration, in a participative way, the Development Plan of the Committee of Users of the Machángara irrigation system. Because of the success of this initiative, a Development Plan of another irrigation system, Chiquintad,[10] has been prepared and actually applied.
- Motivation and technical assistance to the cooperative of savings and credit of Chiquintad[11] to develop an eco-tourism project in the high native forest of Misirriri.
- The first phase of the reforestation program[12] of the middle to high watershed has been completed, with the participation of the parishes of Checa, Chiquintad and Mayancela[13] funded by ELECAUSTRO. The program was designed by the Technical Secretariat and supervised by the Plenary of the Watershed Council. This program has started a new phase in the relations between the of the energy company and the community.
- Communal tree nurseries have been built, that have provided 50 000 plants for the reforestation program, and generated income to the families operating the nurseries.

[9] In cooperation with CNRH

[10] Parish of 3 000 inhabitants.

[11] Counts 110 members, out of which which 55 are active..

[12] 144 ha and 86 400 tree seedlings planted

[13] The parishes have a total of approximately 6 000 inhabitants.

- Workshops on the production of native plants.

- Family vegetable gardens have been promoted (actually there are 60). This program includes motivation, training and follow-up of each one of the participants; it counts on graphic material, work notebooks and videos. The idea is that each participant can provide for their families and at the same time sell their products at local markets.

- A program for the amelioration of pastures and soil conservation is operational, based on farmers' participation and study visits to successful pilot projects. In each part of the watershed, one pilot project has been established, where benefits of the interventions can be appreciated, such as pasture adapted to the climate, that work to form live barriers to fight erosion, at the same time giving food to smaller animals, rotating cultivations, the use of the water and types of cultures, all on behalf of fighting erosion and giving benefits to the farmers.

- A training program is developed with subjects such as the amelioration of pasture, soils, family vegetable gardens, the rational use of water and beekeeping. This program has been divided in adults and children, with monthly meetings in groups of 30 and 40 participants in each event. Target groups are rural and semi-urban parishes. The project is implemented through workshops and practical work in each community, experiences are exchanged and state schools and teachers have been involved to ensure a follow-up.

- A beekeeping program aimed at giving an income to women has been designed, implemented and promoted. It counts actually with 18 participants.

- A project of generation of the aggregated value of alternative forest productssuch as handicrafts, oils and others.

Financing of activities

Until now, the financing of the administration of the Technical Secretariat has been shared by the institutions that form the plenary, with exception of the users' committee which is currently being formed. The activities included in the operative plan for the watershed, are financed and controlled by institutions under the coordination of the Technical Secretariat.

Conclusions and lessons learned

In the case of the Río Machángara, the creation of the Watershed Council was triggered by to the necessity to confront a "common enemy", the competition for water resources.

It has been a difficult and slow process, that is ongoing. The successful outcome will depend on the continued will and co-responsibility of the involved actors, to conclude with a work tool that allows a rational management of the water resource.

Lessons learned

The work of the Watershed Coucil has generated many expectations and impacts, regarding the environmental, technical social and institutional dimensions of natural resources management and especially water management.

Institutionally: The most important lesson is to demostrate that it is possible to work as a team in a coordinated and efficient way. The technicians of the different institutions discovered that they have more in common than they imagined, and that they can establish very solid work links. New initiatives of conservation and production have been generated in the communities of the middle and high watershed, creating links with communities of the lower watershed.

Socially: Opening the doors of the high watershed of the Machángara, in the regions owned and/or protected by the company that generates energy ELECAUSTRO, has generated knowledge and learning experiences for both sides. Technicians were made sensible to the concerns of the mountain community. Jobs were created and a conscience of conservation developed among the members of the upland community, as well as a recovery of their mountain identity.

The women have won spaces, self-esteem and new incomes, being part of new productive projects focused on their problems.

The existing social spaces were not only taken in consideration, but were strengthened, developed and secured, for example the savings and credit cooperative which begun in the seventies and actually is working on an eco-tourism project.

Environmental: The changes in the environment of the watershed are now measured; including quantity and quality of water resources. Information is analyzed and processed, which allows for a better, more informed decision-making process. Reforestation and protection areas exist, especially in the water source areas, river shores and reservoirs. The ecological flow is respected in the Machángara River and its tributaries.

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